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ABSTRACT

We construct panel data on house prices and the determined cause of 4.8 million individual fires in the United States between 1986 and 2010 to test whether decreases in local housing market prices coincided with increases in arson. Since some insured homeowners may attempt to disguise the actual cause of fire as accidental, we also examine how decreases in local house prices are associated with changes in the total number of fires and the probability of determined causes of accidental fires. For the sample period, our results suggest that declines in local house prices coincided with increases in arson, the total number of fires, and the probability that fires were determined to occur due to arson and misuse. We provide further support for the existence of such an effect with empirical evidence that the relation between declines in house prices and arson is stronger in states that allow mortgage lender recourse.

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INTRODUCTION

Arrow (1963) first speculated that economic factors may lead some homeowners to commit arson on their own property due to moral hazard.[1] While empirical evidence regarding the influence of economic factors on the incidence of property crime is well established in the prior literature (see Ehrlich, 1996), the relation between economic conditions and arson is less clear. Volatility of house prices over time, and especially during the Great Recession, leads naturally to the question of whether declines in house prices are related to residential fires caused by arson. In this paper, we construct a panel data series of the determined cause of 4.8 million fires

[1] Prior research provides evidence of other types of insurance-related consumer behaviors tied to prevailing economic conditions. For example, mortality-contingent insurance contracts (e.g., life insurance) experience increases in policy loans and surrenders during times of high interest rates (Outreville, 1990; Liebenberg, et al., 2010).

that occurred in the United States between 1986 and 2010 to test whether decreases in local house prices coincided with increases in arson.[2]

Determining whether arson increases when house prices decrease is important given that arson poses significant danger to human life in neighboring properties and the firefighters attempting to extinguish the fires. In addition to the threat to human life, arson also caused at least $684 million in property damage in 2009 according to the National Fire Prevention Association (Karter, 2010).[3] Given the majority of these damages were on insured properties, increases in arson would result in higher losses for insurance companies and eventually higher premiums for policyholders (Hoyt, 1990).

Our knowledge of whether a relation exists between arson and macroeconomic conditions is limited to a relatively small number of studies beginning with Hershbarger and Miller (1978), Spillman and Zak (1979), and Cloninger (1981). This early research found limited and conflicting evidence using highly-aggregated national arson estimates where other unobserved trends may also be present, as highlighted by Brotman and Fox (1988). More recently, Goebel and Harrison (2012) provide cross-sectional evidence of a higher incidence of arson during 2007 in states with less house appreciation between 2002 and 2006, and it is an important empirical question as to whether their results generalize to other time periods.

[2] We focus on declines in house prices (as a proxy for negative equity) conditional upon changes in other economic factors as Mayer, Pence, and Sherlund (2009) show that recent house price decreases are highly correlated with the shares of homeowners with negative equity, and due to the unique role of house prices in economic motives associated with intentional and accidental fires. We discuss these potential mechanisms in more detail in the next section. In our analysis of arson and declines in house prices, while it is desirable to include homeowner insurance policy coverage characteristics, as suggested by a reviewer, our data unfortunately do not include specific insurance contract information.

[3] These estimates most likely represent the lower bound of the actual economic cost of arson since not all instances of arson may be detected as we discuss later in the paper.

Our analysis complements the cross-sectional results of Goebel and Harrison (2012) and extends the literature in several ways. First, we assemble and use a novel panel data series of arson offenses and accidental fires arguably subject to less reporting bias compared to data from the Uniform Crime Reports (UCR) System used in prior studies.[4] Second, the panel dataset we create allows us to account for area- and time-specific heterogeneity through the use of two-way fixed effects that earlier research was not able to address due to data constraints. Third, whereas previous studies have focused primarily on detected arson offenses, we acknowledge that individuals have strong financial incentives to disguise their behavior as accidental and so we also analyze whether or not decreases in house prices are associated with changes in total fires and the probability of certain types of accidental fires occurring. Fourth, given the richness of our data we are able to test for heterogeneity in effects based on the size of housing price decreases and differences in state mortgage lending laws related to recourse.

The primary source of data we draw upon to create our longitudinal panel is from the National Fire Incident Reporting System (NFIRS) compiled by the United States Fire Administration. The use of NFIRS data offers several advantages for our study, especially considering that the underlying source of NFIRS data is from reports submitted by fire departments and marshals who typically investigate suspicious fires (NFPA, 1998). For example, in Table 1 we compare the average number of reported arson offenses per 1 million MSA residents between 1986 and 2010 in the two data sources. On average, there were 6.465 arson offenses per 1 million MSA residents reported in the NFIRS database each month over

[4] While the Uniform Crime Reporting System (UCR) is the most commonly used source of data when analyzing the effect of economic conditions on criminal offenses, various studies document instances of systematic reporting bias (Ehrlich, 1996; Levitt, 1997; Raphael and Winter-Ebmer, 2001). This reporting bias may be due to perceived stigma, political motivations, or police departments having limited financial resources to submit reports (Ehrlich, 1996).

this time period, as compared to only 0.670 arson offenses per month per 1 million residents in the UCR database.[5]

[TABLE 1 ABOUT HERE]

Our results support the existence of a direct link between housing market price declines and the prevalence of arson. We estimate any decrease in local house prices over the previous 6-months is associated with 0.197 additional arson offenses per 1 million MSA residents per month and a significant increase in probability that a fire in the NFIRS database is determined by fire investigators to occur due to arson.[6] These estimates are statistically significant and conditional upon other observed changes in economic conditions, and are larger than similar estimates using arson data from the UCR database. Results also indicate significant heterogeneity in estimates not previously recognized in the earlier literature. In particular, we show larger increases in arson occur in metropolitan areas with more significant decreases in house prices, or located in a state that allows mortgage lenders the ability to sue borrowers after foreclosure (i.e., recourse). Consistent with some arsonists successfully evading detection, we also provide evidence that declines in local house prices were associated with significant increases in the total number of fires regardless of determined cause, as well as significant increases in the probability of fires due to misuse of material or product as determined by fire investigators. Through use of piecewise linear regressions to allow for different effects based on the size of the decrease in local house prices, our results imply a 10-to-15% decrease in local

[5] Estimates using UCR data alone will be downward biased if police departments were less likely to report arson offenses when house prices decrease. For example, decreases in house prices could result in decreased property tax revenue and police department budgets. We show estimates based on the UCR data are substantially lower than estimates using the NFIRS data later in the paper.

[6] For ease of exposition, the paper going forward generally will use "due to arson" in place of "determined by fire investigators to be due to arson."

house prices was associated with an additional 3.8 fires per 1 million MSA residents per month, and a 2.2% increase in probability an individual fire was due to arson or misuse.

We also provide an estimate of the economic costs of arson by using estimates of property damage reported by fire investigators in the NFIRS data. The National Fire Prevention Association (Karter, 2010) estimates $10.8 billion of property damage due to fire occurred in 2009. Throughout our sample, we estimate a 10-to-15% decrease in local house prices coincided with an 85.5% increase in reported property damage due to fire, or up to $2.9 million per 1 million MSA residents each month. These estimates contribute to the growing literature on various aspects of insurance fraud including opportunism (Dionne and Gagne, 2002), its detection (Derrig, 2002), economic costs (Hoyt, 1990), and claim settlement strategies (Crocker and Tennyson, 2002), as well as the broader literature on the economic costs of recessions (Bajari, Benkard, and Krainer, 2005).[7]

The rest of the paper proceeds as follows. We first briefly review related literature in the next section, followed by a description of the data and empirical methods. We then discuss our empirical evidence on declines in housing market prices and their relation to a) the per capita rate of arson, b) the total number of fires, c) the probability of fires determined to occur by investigators due to either arson or misuse, and d) state laws that govern the ability of mortgage lenders to sue borrowers after foreclosure. The final section concludes with a summary, caveats of the research, and possible areas for future research.

[7] Related literature on asymmetric information and adverse selection also is relevant to the discussion of insurance fraud and arson, including Peng, Zhang, and Valdez (2012), Chiappori and Salanie (2000), and Puelz and Snow (1994), among others, although our data do not include individual insurance contract coverage and arson. Because homeowners insurance is required by virtually all mortgage lenders, and because homeowners insurance contracts are highly standardized in terms of coverages, exclusions, and conditions, the role of moral hazard is viewed as the primary mechanism, at least in the context of our data and analysis, in the relationship between arson and decreases in house prices.

Review of Literature

Economic Motives of Arson

The notion that some insured homeowners may have financial incentives to commit arson on their own property due to moral hazard was originally highlighted by Arrow (1963).[8] Becker (1968) was among the first to develop and popularize theoretical economic motives for criminal activity. These theoretical models, primarily in the context of property theft, imply individual agents seek to maximize their own utility in deciding whether or not to steal the property of another individual, given the probability of detection and subsequent negative consequences if convicted.[9] The theoretical relation between economic conditions and incentives to commit arson are less clear.

Moral hazard has been shown to exist in a variety of different contexts and occurs when one party of a transaction acts to the detriment of another party after the transaction occurs (e.g., see Cummins and Tennyson, 1996; Dionne and Gagne, 2002; Wang, Chung, and Tzeng, 2008). In the context of arson, some homeowners may attempt to disguise intentional fires to their own property as accidental in an attempt to collect insurance proceeds.[10] Based on the economic framework of Becker (1968), this action would be optimal if the expected insurance payout exceeds the current market value of their property conditional on the probability and consequences of detection.

Assuming the probability of detection and the consequences of arson remain constant, financial incentives to commit arson may increase when house prices decrease due to two main

[8] See Rowell and Connelly (2012) for a history of the term "moral hazard."

[9] See Ehrlich (1996) for a review of the literature on the economics of crime.

[10] Homeowners committing arson would attempt to conceal their actions for at least two obvious reasons. First, arson is a criminal offense punishable by an average sentence of 26 months (Hall, 2010); second, the "Intentional Loss" exclusion in homeowner's insurance policies precludes coverage of losses stemming from arson.

reasons. First, replacement cost, which is the basis on which homes are insured, may be higher than market value immediately following home price declines (Cloninger, 1990). Second, homeowners are more likely to have negative equity immediately after price declines (Mayer, Pence, and Sherlund, 2009). Some homeowners with negative equity may therefore view arson as a viable substitute to avoid the pecuniary and non-pecuniary costs of foreclosure.[11]

Changes in macroeconomic conditions also may be associated with an increase in the number of truly accidental fires. While still considered moral hazard (albeit of a more subtle form), insured homeowners may be less vigilant in their prevention efforts or perform less maintenance when economic conditions deteriorate. Changes in unemployment rates could also increase the average number of hours an individual is at home, which may also be correlated with the prevalence of accidental fires.

Empirical Evidence on Arson

Early evidence directly relating economic conditions and arson originated in the late 1970s. This prior research used highly-aggregated time-series data to provide evidence on the possible link between national economic conditions and the prevalence of arson (e.g., Hershbarger and Miller, 1978; Spillman and Zak, 1979; Cloninger, 1981). Brotman and Fox (1988), however, argued and provided evidence the prior relation in the earlier time-series research was an artifact of spurious regressions, and then provided their own cross-sectional evidence of no relation existing using one year of arson estimates in 32 states.

[11] See Foote, Gerardi, and Willen (2008) for a review of the pecuniary and non-pecuniary costs of foreclosure on borrowers; also see Seiler, Seiler, Lane, and Harrison (2012) for a review of other economic and behavioral motivations of mortgage default. Saltz (1999) suggests the common industry practice when accidental fires occur on insured properties with negative equity is for the borrower to voluntarily transfer the property title and insurance payout directly to the mortgage lender in a process called “Deed in Lieu of Foreclosure.”

In their response to Brotman and Fox (1998), Hershbarger and Miller (1988) discuss several empirical concerns of using one year of cross-sectional data to reach too many conclusions. In particular, they highlight the limited power of such an analysis with only a limited number of state-aggregated observations to detect an actual effect if one existed. They also discuss the possibility of unobserved heterogeneity in levels of arson activity at the state level that also may be correlated with levels of economic activity that would lead to their own biased estimates. For example, Brotman and Fox (1998) include the divorce rate, per capita income, poverty rate, percentage change in population between 1970 and 1980, unemployment rate, and business failures as determinants of the percent of total fires due to arson, but omit any role of house prices from their analysis.

More recently, Goebel and Harrison (2012) include house price appreciation in their cross-sectional analysis of the per capita count of arson reported in UCR data at the state and metropolitan level. They find a negative and statistically significant relation between house price appreciation between 2002 and 2006 on the per capita count of arson in 2007, while controlling for several other well-reasoned economic attributes. Their results improve upon prior research but remain subject to possible omitted variable bias and limited generalizability to other time periods given the cross-sectional nature of their analysis. This is especially true given that very few states and metropolitan areas experienced net decreases in house prices between 2002 and 2006, the period Goebel and Harrison (2012) used to measure changes in house prices.

Thus, while prior research has shown a relation between economic conditions and criminal activity more broadly, the question of whether such a relation exists between decreases in house prices and the prevalence of arson remains largely unresolved. One explanation for the inconsistent results in prior research is the heterogeneity between geographical areas in not only determining whether arson occurs, but also whether arson was successfully detected and then reported. We discuss in the next section how we address these empirical concerns.

DATA AND EMPIRICAL METHODS

As discussed above, earlier research has primarily used known offenses reported in the UCR database when analyzing the effect of macroeconomic conditions on crime. When studying economic determinants of arson, focusing only on identified criminal offenses in the UCR is problematic since: 1) local police departments, which are the underlying source of UCR data, may be unaware of pending arson investigations; 2) reporting criminal offenses to the FBI is voluntary and local departments may disproportionally underreport offenses during local economic downturns due to a lack of financial resources to dedicate toward reporting purposes; and 3) because some individuals will attempt to disguise the cause of the fire as accidental, not all arsons may be accurately detected.

To address these empirical concerns we create a panel dataset of the determined cause of individual fires in the NFIRS database between 1986 and 2010. The NFIRS database is organized by the U.S. Fire Administration and is the collection of reports submitted by 14,000 local fire departments on the determined cause and address of individual fires (NFPA, 1998). Our sample is comprised of the 4.8 million structural fires that occurred in 362 metropolitan areas in the United States over that time period.

Using NFIRS data, we conduct three main empirical exercises. First, we test whether the per capita rate of arson (*Arson*) is associated with any recent decrease in local house prices (*Decrease*).[12] In regression form, we estimate:

$$Arson_{mt} = \alpha_t + \delta_m + \gamma_m time_t + \beta(Decrease_{mt}) + \theta X_{mt} + \epsilon_{mt}, \quad (1)$$

where t indexes the month and m indexes the MSA where the reported fire occurred. The variables α_t and δ_m in equation (1) are separate month and MSA fixed effects to control for possible location- and time-specific determinants of arson. For example, certain metropolitan areas (e.g., Detroit, Michigan) have higher-than-average rates of arson regardless of changes in house prices. By allowing a separate intercept, or fixed effect, for each MSA, we are able to remove local time-invariant determinants of arson activity and interpret β from equation (1) as the extent to which any decrease in local house price coincided with higher than average rates of arson. To the extent that unobserved local trends may also exist, $time_t$ is a time trend variable that is separately estimated for each MSA, as suggested by Friedberg (1998), to remove unobserved trends and possible serial correlation in errors.

While the fixed effects absorb time- and location-specific heterogeneity in arson rates, our estimates will be biased if there are time-variant omitted determinants of arson dually-correlated with decreases in house prices. To additionally guard against this possibility, the variable X represents a vector of observed economic conditions that vary across MSAs and time. These economic indicators we include in the model, as controls, are the natural log of unemployment and housing vacancy rates, and growth rates of population and per capita

[12] House price indexes were obtained at the MSA-level from the Federal Housing Finance Agency. This quarterly data was transformed to monthly by assuming any reported changes in the price index occurred in a linear fashion over each month. For example, if house prices decreased by 3% over the previous quarter, we would assume they decreased 1% each month.

income.[13] We also include in X the change in quality-adjusted local housing rents created by Carillo, Early, and Olsen (2013) to capture any remaining heterogeneity. Given our control variables and fixed effects, our empirical estimates are identified by changes in per capita arson rates specifically associated with housing market price declines that differ from prevailing long-term trends conditional upon other changes in local economic conditions.

The relation between decreases in house prices and arson is expected to be non-linear, in the sense that the incentives to commit arson likely increase as house prices further decrease. To accommodate the unknown shape of such effects, we specify the relation using a series of dummy variables and splines. For example, we initially test whether any recent decrease in local house prices occurred in the metropolitan area as measured during the previous 6 months using a 0,1 dummy variable.[14] In such regressions the coefficient β in equation (1) will indicate the change in the total number of arsons associated with a decrease in local house prices during the previous 6 months as relative to metropolitan areas not experiencing any price decrease. We will also test the relation using piecewise linear regressions of housing price declines between 0-to-5%, 5-to-10%, 10-to-15%, 15-to-20%, 20-to-25%, and greater than 25%.

The central hypothesis is that $\beta = 0$, or that decreases in house prices are not associated with the prevalence of arson, versus the alternative that $\beta > 0$, that decreases in local house prices are associated with the prevalence of arson. We suspect our estimate of β in equation (1) will be

[13]Annual growth rates in population and per capita income were calculated from U.S. Bureau of Economic Analysis data. Unemployment rates were obtained at the state level from the U.S. Bureau of Labor Statistics, since estimates below the state level were not available prior to 1990. Owner-occupied vacancy rates were obtained from the Census Bureau. A limitation of the analysis is that the model does not control for possible variation in explicit criminal enforcement activity across geography, time, and economic conditions, other than in the form of time and MSA controls. Inclusion of such controls may further strengthen the analysis, although, to our knowledge, such ideal enforcement variables do not exist.

[14]While the effects are greatest when measuring house price decreases over the previous 6-month period, results are generally robust to measuring house price differences over the previous 3-month or 12-month periods, with qualitatively similar results.

biased downward if detection and subsequent reporting of arson by local fire departments to NFIRS is systematically correlated with local housing market conditions. To address possible reporting bias, the second empirical exercise we conduct is to test whether recent decreases in local house prices were associated with an increase in the probability an individual fire reported to NFIRS is determined to occur due to arson. More specifically, we estimate equation (2):

$$Cause_{imt} = \alpha_t + \delta_m + \gamma_m time_t + \beta(\text{Decrease}_{mt}) + \theta X_{imt} + \epsilon_{imt}, \tag{2}$$

where *m* and *t* index MSA and calendar-month as before, but *i* now represents an individual fire reported in the NFIRS database. The dependent variable, *Cause*, is a 0,1 indicator variable whether a reported individual fire *i* was determined to occur due to arson or another determined cause of fire by investigators. The other variables are similarly defined as in equation (1) when analyzing the per capita rate of arson. Due to multiple fires occurring in the same MSA each month resulting in possible non-independence of the error term, we cluster our standard errors at the MSA level monthly.

It is important to emphasize that the determined cause of an individual fire is our unit of observation when estimating equation (2), where β now represents the marginal difference in the probability an individual fire is determined to occur due to arson conditional upon our control variables and being reported to the NFIRS database. This alternative estimation strategy will be robust to reporting bias if the decision by fire departments to submit reports to NFIRS is independent of the underlying cause assigned for individual fires. Estimates of β in equation (2) will still be downward biased if fire departments are systematically less likely to detect arsons as a direct result of a decrease in local house prices. As mentioned above, this could occur due to either a lack of resources to investigate potential arson by fire departments or due to increased individual incentives to disguise intentional fires as accidental. Given these reasons, we also investigate how house price declines are associated with increases in the total number of fires and the probability of other types of fires besides arson.

EMPIRICAL RESULTS

Per Capita Rate of Arson

Summary statistics of the regression variables are reported in Table 1. The first column displays the mean of each variable, while the second through fourth columns display the standard deviation, minimum, and maximum of that variable. On average, 98.4 fires were reported per 1 million MSA residents in the NFIRS database each month between 1986 and 2010, of which 6.5 fires due to arson. During the same time period, only 0.7 fires per 1 million residents were reported in metropolitan areas according to the UCR database.

The solid line in Figure 1 indicates nationally-aggregated house prices according to the Federal Housing Finance Agency (FHFA). We find that despite relatively constant growth in nationally-aggregated house prices prior to 2007, local house prices were far more volatile with 21.0% of metropolitan areas experiencing any decrease in local house prices over the previous 6 months throughout our sample. The vertical bars in Figure 1 indicate the percent of MSAs with recent declines in house prices, indicating 8 distinct spikes of at least 30% of metropolitan areas with recent housing price declines. Over this period, relatively small decreases in local house prices between 0-to5% were most common (18.5% of the sample) followed by decreases between 5-to-10% (1.9%), 10-to15% (0.4%), 15-to-20% (0.1%), 20-to-25% (0.1%), and greater-than-25% (0.1%).

The last five rows in Table 1 illustrate descriptive statistics for the economic conditions we use as control variables in our analysis. According to the Bureau of Labor Statistics, the average unemployment rate was 5.6% between 1986-2010, and the average growth rate of per capita income and population was 1.1% according to the Bureau of Economic Analysis. We also find the average housing vacancy rate was 8.4% and the 6-month change in quality-adjusted housing rent was 1.4%.

[FIGURE 1 ABOUT HERE]

Table 2 presents coefficient estimates of equation (1) using UCR and NIFRS data. The dependent variable, *Arson*, is defined as the monthly rate of arson per 1 million MSA residents between 1986 and 2010 in each data series. There were 59,745 and 85,944 unique MSA-by-month observations in the UCR and NFIRS data, respectively, which is the unit of observation for the analysis. We report in the first column of Table 2 there were an additional 0.031 monthly instances of arson detected and reported per 1 million residents in the UCR database in MSAs experiencing any decrease in house prices during the previous 6 months. That estimate is conditional upon the 362 MSA fixed effects, 300 monthly time fixed effects, and 362 linear time trends to control for MSA- and time-specific heterogeneity. In the second column of Table 2, we report the introduction of additional control variables for economic conditions as specified as *X* in equation (1) has virtually no effect on our coefficient estimate on any decrease of local house prices on per capita arson rates reported in the UCR data.[15] Huber-White standard errors, robust to heteroscedasticity, are reported in parentheses and indicate statistical significance of those coefficients for recent decreases at the 5% level.[16]

[15] Caution is urged when interpreting the coefficients on the economic control variables given their conditional nature with the other control variables in the model. Whereas the estimate on decreases in local house prices is largely robust, the coefficients on the other economic control variables can differ based on the set of other control variables included in the model.

[16]Whereas our unit of analysis is at the MSA-level each month, only annual housing vacancy and unemployment rates were available at the state-level back to 1986. Although the estimated coefficient on Decrease in Local House Prices is largely unaffected, the standard errors on each of the two variables are most likely downward biased given the non-independence of those variables in states with multiple metropolitan areas. Also, the

[TABLE 2 ABOUT HERE]

We report coefficients in the third and fourth columns of Table 2 from re-estimating equation (1) using instead monthly arson offenses reported in the NFIRS database.[17] Depending on the inclusion of additional economic control variables, we estimate MSAs with any decrease in local house prices experienced between 0.178 and 0.197 additional arson offenses per 1 million residents each month. As before, these coefficient estimates are statistically distinct from 0 at the 5% level of significance using standard errors robust to heteroscedasticity.

In Table 3, we relax the assumption of a constant effect regardless of the size of the decrease in local house prices. More specifically, equation (1) is re-estimated where the single dummy variable indicating whether the MSA experienced any decrease in local house prices over the previous 6 months is instead replaced with a series of dummy variables indicating the extent to which, if any, the MSA experienced a decrease in local house prices between 0-to-5%, 5-to-10%, 10-to-15%, 15-to-20%, 20-to-25%, and greater than 25%. Consistent with necessary trigger events to overcome fixed transactions costs in the foreclosure literature, we anticipate a non-constant effect with arson becoming more attractive given larger decreases in house prices (e.g., see Vandell, 1995; and Ambrose and Capone, 1998).

[TABLE 3 ABOUT HERE]

The coefficient estimates reported in the first column of Table 3 indicate significant heterogeneity in effects exists in per capita arson rates depending on the size of the decrease in

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adjusted r-square values are similar across specifications because of the large degree of variation absorbed by the MSA and monthly fixed effects, in addition to a separate time trend for each MSA.

[17] As illustrated in Table 1, significantly fewer arson offenses are reported each month in the UCR data as compared to the NFIRS database resulting in possible attenuation bias due to measurement error. We provide evidence of such bias by estimating significantly larger coefficient estimates when monthly arson offenses per 1 million MSA residents in the NFIRS database is alternatively specified as the dependent variable.

local house prices.[18] Whereas we estimate small decreases in local house prices of 0 and 5% were associated with 0.175 additional arson offenses per 1 million MSA residents each month, we estimate 0.887 and 1.773 additional arson offenses per 1 million residents in MSAs experiencing between 5-to-10% and 10-to-15% decreases in local house prices, respectively. The solid line in Figure 2 represents visually the pattern of coefficient estimates where the y-axis is defined as the additional number of arson offenses per month and the x-axis is defined as the percent decrease in local house prices. Given evidence of the strong non-linearity of arson effects when decreases in local house prices occur, we only present estimates of the piecewise regressions for the remainder of the analysis.

[FIGURE 2 ABOUT HERE]

Total Fires

While arson estimates obtained using the NFIRS data were shown to have less reporting bias than using UCR data, such estimates may still be downward biased if either decreases in local house prices resulted in fewer resources to investigate potential arson offenses, or if more individuals are successful in disguising their intentional behavior as accidental when house prices decrease. Alternatively, such estimates may be upwardly biased if fire investigators were aware of possible economic incentives and incorrectly concluded a truly accidental fire was intentional.

To address these potential concerns, we re-estimate equation (1) alternatively defining the dependent variable as the total number of fires per 1 million MSA residents in the NFIRS

[18] A joint F-test of the hypothesis that the coefficients are equal is rejected at the 1% level of significance.

database regardless of cause determined by fire investigators.[19] As listed in Table 1, there were on average 98.438 fires per 1 million MSA residents each month. Coefficient estimates are reported in the second column of Table 3, which continues to relax the assumption of a constant effect of house price declines by instead using a series of dummy variables to estimate a piecewise linear regression. Whereas we estimated a relatively small increase in the per capita rate of arson when local house prices decrease between 0 and 5%, we estimate a statistically significant decrease in the total number of fires for these same MSAs. Consistent with some possible arsonists successfully evading detection, we estimate much larger effects for decreases in local house prices greater than 5%. These coefficient estimates are illustrated in Figure 3 and are statistically different from 0 for decreases in local house prices between 10-to15%, 20-to-25%, and greater than 25%. For those MSAs experiencing a decrease in local house prices between 10-to-15%, there were 3.788 additional fires per 1 million residents as compared to only 1.773 additional arson offenses.

[FIGURE 3 ABOUT HERE]

Change in Probability of Determined Cause of Fires

The above aggregate estimates of the per capita rate of arson and total fires could still be downward biased if fire investigators systematically under report arson and fires to the NFIRS database when house prices decrease. For example, Levitt (1997) provides evidence that police underreport criminal offenses to the UCR database based on mayoral electoral cycles. Alternatively, decreases in house prices may result in decreases in property taxes and thus reductions in resources to investigate and report cause of fires to the database. As evidence this

[19] The UCR database does not provide the number of fires due to any cause, and thus the re-estimation here is based on the NFIRS data.

may occur in the NFIRS database, 36.4% of the 85,944 MSA monthly observations indicate no arson offenses occurred during the prior month throughout the entire MSA. For these areas, it is unclear whether no arson actually occurred or if arson occurred but either was not detected or not reported to the NFIRS database.

To address potential reporting bias, we estimate the conditional change in probability an individual fire reported to the NFIRS is determined by fire investigators to occur due to arson. This estimate will be free from reporting bias if the decision to submit a report to NFIRS is independent of the determined cause assigned by investigators.

There were 4.8 million fires reported to the NFIRS database between 1986 and 2010 involving a structure, of which 8.0% were determined by investigators due to arson. Coefficient estimates of the conditional change in probability of a fire determined due to arson associated with decreases in local house prices in 5% intervals are reported in the first column of Table 4.[20] The standard errors reported in parentheses below each estimate are now clustered at the 85,944 unique MSA monthly observations to account for the possible non-independence of errors when multiple fires are reported during the same month in each MSA.

[TABLE 4 ABOUT HERE]

Conditional upon the full set of fixed effects and economic control variables, we estimate the probability an individual fire was due to arson increased at least 0.3% to 1.4%, depending on the magnitude of the house price decrease. All of the coefficient estimates on the price decrease variables between 0 and 20% were different from 0 at least at the 5% level of

[20] The coefficients throughout Table 4 were obtained by estimating a linear probability model (LPM) due to less strict assumptions required about the structure of the error term in equation (2). Hausman (2001) suggests that the presence of measurement error, such as that likely to exist in our analysis, significantly decreases the likelihood that alternative probit and logit estimators will be consistent. Average marginal effects obtained from a probit estimator were almost identical to those obtained using the LPM.

significance, and were largest (1.4%) when a 10-to-15% decrease in local house prices occurred. Decreases in local house prices between 20-to-25% were associated with a 1.1% increase in probability of fires due to arson (at the 10% level of significance).

We also test the relation between decreases in local house prices and the probability of each of the four main types of determined cause of accidental fires in the NFIRS database: misuse, mechanical, electrical, and operational (plus those of unknown cause). The only cause for which a significant relation appears is misuse. That is, decreases in local house prices were significantly associated with an increased probability of individual fires determined to occur due to misuse.[21] Coefficient estimates of the increase in probability of fires due to misuse are reported in the second column of Table 4.[22] Consistent with the effect on the total number of fires, we see a decreased probability of fires due to misuse for small decreases in local house prices between 0 and 5%, but significant increases in probability when larger price decreases occur. The largest significant increase in probability of fires due to misuse was estimated for decreases in local house prices between 20-to-25%.

The third column of Table 4 reports the increase in probability of fires determined to occur due to either arson or misuse. In all instances, the coefficients are close to the sum of the increase in probability of fires due to arson or due to misuse estimated separately in the first and second columns of the table. Those probabilities range from 1.0% in MSAs with house price declines between 5-to-10%, are approximately 2.2% for house price declines between 10-

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[21] Examples of fires due to misuse of material or product include: abandoned or discarded materials, heat source too close to combustibles, spilled flammable liquid, improper fueling technique, improper container or storage procedure, and playing with a heat source. Of all fires, 19.7% were determined by investigators due to this accidental cause between 1986 and 2010. See Ahrens (2013) for a complete list and more formal discussion of determined cause of fires reported within the NFIRS database.

[22] Results for the other causes of accidental fires (mechanical, electrical, and operational) were insignificant and are available upon request.

to-25%, and exceed 3.7% when declines in house prices are greater than 25%. These coefficients are represented visually in Figure 4 with the increased probability defined as the y-axis and the size of the decrease in 5% intervals.

[FIGURE 4 ABOUT HERE]

Economic Costs of Arson

Another advantage of the NFIRS database is that investigators provide an estimate of property damage for individual fires, which is not available for arson offenses reported in the UCR database. These loss estimates can be used, in turn, to determine if property damage increase in local areas experiencing a recent decrease in local house prices, and thus the economic costs of arson.

In practice, a $0 estimate is reported for 38.9% of the 4.8 million fires submitted, so it is unclear if either no loss actually occurred for those fires, or if a loss occurred but no estimate of that loss was available to report. We attempt to partially circumvent these measurement-related issues to obtain a consistent estimate of the cost of arson by estimating equation (1) with the dependent variable defined as the natural log of monthly aggregated property damage due to fire loss. This will enable us to interpret β in equation (1) now as the % change in aggregate fire loss when local house prices decrease assuming the decision by investigators to submit an estimate of damages is independent of a decrease in house prices occurring. If investigators were less likely to submit an estimate of damage as a direct result of decreases in house prices, perhaps due to a decrease in financial resources to investigate fires or report estimates to NFIRS, then our estimate would be a lower bound of the true costs.[23]

From Table 1, there was on average $1.640 million in estimated property damage from fires each month per 1 million MSA residents across our sample.[24] We estimate equation (3) (similar to equation (1)) where the dependent variable *PropertyDamage* is instead defined as the natural log of monthly aggregate property damage due to fire:

$$PropertyDamage_{mt} = \alpha_t + \delta_m + \gamma_m time_t + \beta(Decrease_{mt}) + \theta X_{mt} + \epsilon_{mt}, \quad (3)$$

where *t* indexes the month and *m* indexes the MSA where the property damage occurred, and the other variables are as defined earlier. Table 5 provides coefficients estimates for equation (3). The first column of Table 5 reports coefficient estimates associated with local house price declines in 5% intervals conditional on the full set of fixed effects and trends, but not conditional on the various economic control variables. The coefficients in the second column are conditional on the same control variables of economic conditions as equation (1). As before, Huber-White robust standard errors are reported in parentheses below each estimate.

[TABLE 5 ABOUT HERE]

We estimate a near monotonic relationship between magnitudes of declines in local house prices and estimated property damage due to fire. Since the dependent variable is the natural log of estimated property damage, the coefficients can be interpreted as the percent increase in loss given house price declines of each magnitude. Whereas no estimated increases

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[23] We find evidence that a decrease in local house prices was correlated with a $0 loss estimate being submitted to the NFIRS database, supporting our suspected downward bias. Conversely, our estimates could be upwardly biased if fire investigators were instead more likely to submit property damage estimates as a direct result of a decrease in local house prices. Although possible, the exact mechanism why investigators would be more likely to submit damage estimates when house prices decrease is less clear.

[24] All dollar estimates are in 2010 dollars adjusted for inflation by the Consumer Price Index produced by the US Bureau of Labor and Statistics.

in damages were reported in MSAs experiencing relatively small decreases in house prices (i.e., between 0 and 5%), economic and statistically significant increases in losses were observed in MSAs with at least a 5% decrease in local house prices. Metropolitan areas with a 5-to-10% recent decrease in local house prices experienced a 33.6% increase in estimated property damages, which increase to a high of a 202.0% increase in local areas with a house price decrease of between 20-to-25% over the last 6 months. Figure 5 visually displays the coefficient estimates.

[FIGURE 5 ABOUT HERE]

Given on average $1.64 million in property damage from fires are reported to the NFIRS database each month per 1 million MSA residents, our estimates in Table 5 imply a 10-to-15% decrease in local house prices is associated with $0.84 million in additional monthly property damage, or $10.1 million on an annualized basis, per 1 million MSA residents.[25] These dollar estimates of loss would represent a lower bound of the true cost if an actual loss occurred for the 38.9% of fires in the NFIRS database with no reported loss. Karter (2010) attempts to correct for such potential reporting and measurement error, and estimates that $10.8 billion in property damage occurred due to fires in 2009. Using this alternative loss estimate, our estimated effect would imply a 10-to-15% decrease in house prices would coincide with an additional $17.8 million in property damage per 1 million MSA residents.[26]

[25] The estimate of additional damage per 1 million MSA residents is calculated as $1.64 million * 0.512 * 12 months. We thank an anonymous reviewer for suggesting the analysis of economic costs of arson.

[26] According to the 2010 Decennial Census, 308.7 million people were living in the United States. Thus, on average, $2.9 million in property damage occurred in the United States for every 1 million people every month as compared to $1.64 million in monthly damages reported in the NFIRS database.

Evidence in Recourse States

Significant variation in mortgage lending laws exists between states, and this variation potentially alters the relative attractiveness of foreclosure versus arson vis-à-vis borrowers with negative home equity (e.g., see Seiler, Seiler, Lane, and Harrison, 2012). Prior research indicates borrowers facing foreclosure are aware of the ability for mortgage lenders in some states to sue, or seek a deficiency judgment, if the lender incurs a loss as a result of foreclosure (Ghent and Kudlyak, 2011). Such states are said to enable a mortgage lender "recourse" by enabling them to place an unsecured claim against the borrower's other assets to recover the lender's loss. In the context of arson and house price declines, arson is expected to be a relatively more attractive alternative as compared to foreclosure for borrowers in those states where lenders are allowed recourse. Thus, we next examine whether the relation between house price declines and arson is stronger in states that allow mortgage lender recourse. [27]

According to Ghent and Kudlyak (2011), mortgage lending laws in 11 states prohibit mortgage lenders seeking recourse after foreclosure.[28] Table 6 provides aggregate means of arson and economic conditions at the metropolitan level in states that either prohibit or allow recourse after foreclosure. As initial evidence of a difference in behavior, we find in the NFIRS data a higher per capita incidence of arson and the total number of fires regardless of cause occurring in those states that allow recourse.[29]

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[27] We also considered stratifying our estimates by differences in bankruptcy homestead laws between states, although only 2 states (i.e., Florida and Texas) protect the homestead from bankruptcy, thus making it difficult to disentangle the actual effect from other observed and unobserved state attributes. The lack of exogenous variation does not enable us to reach stronger conclusions here.

[28] We acknowledge an anonymous reviewer for suggesting this extension. Ghent and Kudlyak (2011) identify the 11 states prohibiting mortgage lender recourse as: Alaska, Arizona, California, Iowa, Minnesota, Montana, North Carolina, North Dakota, Oregon, Washington, and Wisconsin.

[29] We also find further evidence of problematic measurement error of arsons reported in the UCR database; only 1 fire is reported in the UCR database for every 20 reported in the NFRIS database in states that allow lender recourse. With the exception of fires reported in the UCR database, decreases in local house prices and other

[TABLE 6 ABOUT HERE]

We present in Table 7 coefficient estimates of piecewise linear regressions where we stratify our sample by the ability of a mortgage lender to seek recourse. Similar to Table 2, the dependent variable, *Arson*, in Table 7 is defined as the monthly number of arson offenses per 1 million MSA residents in the NFIRS database. The observations in the first column of reported estimates are restricted to the 94 MSAs located in the 11 states that prohibit recourse. The observations in the second column are restricted to the 268 MSAs located in states that allow recourse. As before, the regressions used to estimate the coefficients also include the full set of MSA and year fixed effects.[30]

[TABLE 7 ABOUT HERE]

As anticipated, we estimate the largest increases in arson when local house prices decline in the metropolitan areas in states that enable mortgage lender recourse after foreclosure. Whereas we estimate no statistically significant relation between declines in house prices and increases in arson in states that prohibit lender recourse, we do estimate a statistically significant relation in states allowing lender recourse. For example, for MSAs experiencing between a 10-to-15% decrease in recent prices, there were 1.934 additional arson offenses (significant at .01 level) in recourse states per 1 million MSA residents as compared to 0.722 (statistically insignificant) additional arson offenses in non-recourse states. In the third column of Table 7 we report the F-statistics, and corresponding p-value in brackets, of joint statistical tests that the effects are similar in recourse and non-recourse states. We find the effects are

economic variables are otherwise similar in recourse and non-recourse states. The following analysis is based on NIFRS data as results based on UCR data were insignificant.

[30] It is important to note that the MSA fixed effects are perfectly collinear with recourse laws since no states change the ability of mortgage lenders to pursue recourse as a result of foreclosure in our sample. Given this, we are unable to causally state whether the observed differences in effects are actually due to lender ability to seek recourse or another state-specific attribute.

statistically different at least at the 5% level of significance when house prices decline between 0-to-5%, 10-to-15%, and 20-25%.

Conclusion

We add to the literature on insurance fraud and the role of moral hazard in insurance markets by providing evidence that decreases in house prices at the metropolitan level between 1986 and 2010 were associated with significant increases in the per capita arson rate and the probability of fires due to arson. Our analysis improves upon prior research by assembling a panel data series of the determined cause of 4.8 million fires that occurred in 362 metropolitan areas in the United States that allows us to control for time- and location-specific heterogeneity not accounted for in earlier studies. Our findings complement and extend results in Goebel and Harrison (2012) who demonstrate a statistically significant and negative relation between house price appreciation and arson in their cross-sectional analysis of the per capita count of arson.

Overall, our findings are robust to a variety of alternative specifications and inclusion of additional proxies of local economic conditions supporting the hypothesis of a direct relation between declines in house prices and the prevalence of arson. We also provide evidence of a direct relation between house price declines and increases in the total number of fires.

Consistent with our hypothesis that arson may be an alternative to foreclosure for some borrowers with negative equity, we also extend the literature by showing increases in arson were greatest in recourse states–i.e., in states that allow mortgage lenders to sue to recover losses after foreclosure. The literature may benefit from future research that investigates how other differences in mortgage lending laws or insurance contracts relate to individual incentives to commit arson. Our findings imply insurers should be especially attuned to possible arson-related insurance fraud during periods of house price declines.

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TABLE 1
SUMMARY STATISTICS OF ARSON AND ECONOMIC EXPLANATORY VARIABLES

	mean	standard deviation	min	max
National Fire Incident Reporting System				
Arson	6.465	9.074	0.000	205.846
Total Fires	98.438	68.641	0.103	930.404
Fires Determined Due to Misuse	17.552	16.925	0.000	209.793
Property Damage	1.640	6.387	0.000	888.445
Uniform Crime Reports				
Arson	0.670	3.125	0.000	142.818
Federal Housing Finance Agency				
Local House Price Growth Last 6 months	0.017	0.033	-0.369	0.283
Decrease in Local House Prices	0.210	0.408	0.000	1.000
Decrease in Local House Prices Between				
0 and 5%	0.185	0.388	0.000	1.000
5% and 10%	0.019	0.138	0.000	1.000
10% and 15%	0.004	0.065	0.000	1.000
15% and 20%	0.001	0.035	0.000	1.000
20% and 25%	0.001	0.023	0.000	1.000
Greater Than 25%	0.001	0.018	0.000	1.000
Additional Economic Variables (*X*)				
Unemployment Rate	0.056	0.014	0.015	0.153
Growth Rate of Per Capita Income	0.011	0.024	-0.309	0.245
Growth Rate of Population	0.011	0.013	-0.293	0.100
Housing Vacancy Rate	0.084	0.014	0.026	0.258
Change in Housing Rent	0.014	0.007	-0.029	0.047

Notes: All arson and fire data are defined as per 1 million MSA residents each month and are limited to those involving a structure. Property Damage is property damage due to fires and is in millions of dollars per 1 million MSA residents per month. National Fire Incident Reporting System data obtained from the United States Fire Administration and includes 85,944 unique MSA by month observations in 362 MSAs between 1986 and 2010. Uniform Crime Reports data obtained from the Federal Bureau of Investigation. Growth rates in MSA house prices are moving averages, based on the preceding 6-month period and obtained from the Federal Housing Finance Agency. Unemployment rates obtained from Bureau of Labor Statistics and annual growth rates of population and per capita income obtained from the Bureau of Economic Analysis. Annual housing vacancy rates obtained from the Census Bureau and recent change in housing rent is quality-adjusted as estimated by Carillo *et al* (2013). "Decrease in Local House Prices" is equivalent to *Decrease* in equation (1) and is defined as 1 for when any decrease in local house prices occurs, and 0 otherwise. "Decrease in Local House Prices Between" is defined as 1 for decreases in house prices between the lower and upper limit (e.g., 0 and 5%), and 0 otherwise.

TABLE 2
MONTHLY NUMBER OF REPORTED ARSON OFFENSES PER 1 MILLION MSA RESIDENTS WITH RESPECT TO ECONOMIC CONDITIONS IN UNIFORM CRIME REPORTING SYSTEM (UCR) AND NATIONAL FIRE INCIDENT REPORTING SYSTEM (NFIRS) DATA

	(1)	(2)	(3)	(4)
	Arson (UCR)		Arson (NFIRS)	
Decrease in Local House Prices	0.0310**	0.0314**	0.178**	0.197**
	(0.014)	(0.015)	(0.082)	(0.086)
Unemployment Rate		-0.0759*		-0.339*
		(0.039)		(0.188)
Growth Rate of Per Capita Income		-0.908***		-0.311
		(0.346)		(1.398)
Growth Rate of Population		-0.024		-1.133
		(0.661)		(2.868)
Housing Vacancy Rate		-0.029		-0.502***
		(0.028)		(0.152)
Change in Housing Rent		-2.489**		-35.347***
		(1.177)		(6.451)
Observations	59,745	59,745	85,944	85,944
Adjusted R^2	0.795	0.796	0.604	0.604

Notes: The dependent variable, Arson, in each regression is the reported number of arson offenses per month per 1 million MSA residents by fire departments in the National Fire Incident Reporting System (NFIRS) and Uniform Crime Reporting data between 1986 and 2010. All regressions also include MSA and year-month fixed effects and a separate linear time trend for each MSA. Huber-White robust standard errors are in parentheses. Asterisks indicate statistical significance of coefficients at the following levels: * $p < 0.1$, ** $p < 0.05$, ***, $p < 0.01$. "Decrease in Local House Prices" is equivalent to *Decrease* in equation (1) and is defined as 1 for when any decrease in local house prices occurs, and 0 otherwise.

TABLE 3
MONTHLY NUMBER OF REPORTED ARSON OFFENSES AND TOTAL FIRES OF ANY DETERMINED CAUSE PER 1 MILLION MSA RESIDENTS WITH RESPECT TO ECONOMIC CONDITIONS IN THE NATIONAL FIRE INCIDENT REPORTING SYSTEM (NFIRS) DATA

	(1) Arson	(2) Total Fires
Decrease in Local House Prices Between		
0 and 5%	0.175**	-1.042**
	(0.086)	(0.513)
5% and 10%	0.887***	1.504
	(0.216)	(1.160)
10% and 15%	1.773***	3.788**
	(0.377)	(1.882)
15% and 20%	0.637	2.922
	(0.580)	(3.098)
20% and 25%	0.800*	9.347***
	(0.460)	(2.959)
Greater Than 25%	1.571	26.964***
	(1.070)	(5.836)
Unemployment Rate	-0.356*	1.518
	(0.188)	(1.198)
Growth Rate of Per Capita Income	0.306	11.055
	(1.407)	(7.913)
Growth Rate of Population	0.112	-3.072
	(2.873)	(18.702)
Housing Vacancy Rate	-0.536***	-0.088
	(0.153)	(0.959)
Change in Housing Rent	-35.443***	164.374***
	(6.449)	(42.625)
Observations	85,944	85,944
Adjusted R^2	0.604	0.875

Notes: The dependent variable, Arson or Total Fires, in each regression is the monthly reported number of reported arson offenses or the total number fires of any cause per 1 million MSA residents in the National Fire Incident Reporting System (NFIRS) between 1986 and 2010 in each column, respectively. All regressions also include MSA and year-month fixed effects and an MSA-specific linear time trend. Huber-White robust standard errors are in parentheses and asterisks indicate statistical significance of coefficients at the following levels: * p < 0.1, ** p < 0.05, ***, p < 0.01.fixed effects and an MSA-specific time trend. Standard errors are in parentheses and asterisks indicate statistical significance of coefficients at the following levels: * p < 0.1, ** p < 0.05, ***, p < 0.01. The first six variables in the table are the result of a piecewise regression where separate coefficients are estimated according to the magnitude of the recent decrease in local house prices in 5% intervals. "Decrease in Local House Prices Between" is defined as 1 for decreases in house prices between the lower and upper limit (e.g., 0 and 5%), and 0 otherwise.

TABLE 4
CHANGE IN PROBABILITY AN INDIVIDUAL REPORTED FIRE IS DETERMINED TO OCCUR DUE TO ARSON OR MISUSE WITH RESPECT TO SIZE OF RECENT DECREASE IN LOCAL HOUSE PRICES IN THE NATIONAL FIRE INCIDENT REPORTING SYSTEM (NFIRS) DATABASE

	(1)	(2)	(3)
	Change in Probability of an Individual Fire Determined by Fire Investigators to Occur Due to _________		
	Arson	Misuse	Arson or Misuse
Decrease in Local House Prices Between			
0 and 5%	0.003** (0.001)	-0.002* (0.001)	0.001 (0.001)
5% and 10%	0.006*** (0.002)	0.003 (0.002)	0.010*** (0.003)
10% and 15%	0.014*** (0.004)	0.008** (0.004)	0.022*** (0.005)
15% and 20%	0.011** (0.006)	0.013* (0.007)	0.023*** (0.008)
20% and 25%	0.011* (0.006)	0.017* (0.009)	0.022** (0.011)
Greater Than 25%	0.018 (0.014)	0.017 (0.015)	0.037** (0.018)
Unemployment Rate	0.019*** (0.002)	-0.003 (0.002)	0.016*** (0.003)
Growth Rate of Per Capita Income	0.027** (0.014)	-0.001 (0.014)	0.032* (0.018)
Growth Rate of Population	-0.007 (0.025)	0.069 (0.042)	0.076* (0.044)
Housing Vacancy Rate	-0.009*** (0.001)	-0.007*** (0.002)	-0.016*** (0.002)
Change in Housing Rent	-0.057 (0.058)	0.081 (0.064)	0.039 (0.082)
Observations	4,807,276	4,807,276	4,807,276
Month by MSA Clusters	85,944	85,944	85,944
Adjusted R^2	0.103	0.220	0.305

Notes: The dependent variable is a 0,1 indicator variable whether an individual fire is determined to occur by fire investigators due to arson or misuse of materials as described in the text. Estimates were obtained using a linear probability model and were also conditional upon unemployment rates, growth rates of per capita income and population, housing vacancy rates, and change in quality-adjusted housing rents, MSA, and time fixed effects and a separate linear time trend for each MSA. Cluster robust standard errors at the MSA-by-Month level are reported in parentheses and asterisks indicate statistical significance of coefficients at the following levels: * p < 0.1, ** p < 0.05, ***, p < 0.01. The first six variables in the table are the result of a piecewise regression where separate coefficients are estimated according to the magnitude of the recent decrease in local house prices in 5% intervals. "Decrease in Local House Prices Between" is defined as 1 for decreases in house prices between the lower and upper limit (e.g., 0 and 5%), and 0 otherwise.

TABLE 5
CHANGE IN ESTIMATED PROPERTY DAMAGES DUE TO FIRES WITH RESPECT TO ECONOMIC CONDITIONS IN THE NATIONAL FIRE INCIDENT REPORTING SYSTEM (NFIRS) DATABASE

	(1)	(2)
	Property Damage Due to Fire	
Decrease in Local House Prices Between		
0 and 5%	0.008	0.001
	(0.036)	(0.039)
5% and 10%	0.336***	0.336***
	(0.094)	(0.098)
10% and 15%	0.517***	0.512**
	(0.197)	(0.200)
15% and 20%	0.870***	0.855***
	(0.328)	(0.329)
20% and 25%	2.032***	2.020***
	(0.305)	(0.303)
Greater Than 25%	1.816***	1.790***
	(0.402)	(0.399)
Unemployment Rate		0.373***
		(0.094)
Growth Rate of Per Capita Income		-0.704
		(0.710)
Growth Rate of Population		3.633**
		(1.849)
Housing Vacancy Rate		-0.321***
		(0.080)
Change in Housing Rent		-10.396***
		(3.337)
Observations	85,944	85,944
Adjusted R^2	0.930	0.930

Notes: The dependent variable is the natural log of MSA aggregated property damage due to fire in the National Fire Incident Reporting System (NFIRS) data between 1986 and 2010 in each column, respectively. All regressions also include MSA and year-month fixed effects and an MSA-specific linear time trend. Huber-White robust standard errors are in parentheses and asterisks indicate statistical significance of coefficients at the following levels: * p < 0.1, ** p < 0.05, ***, p < 0.01.fixed effects and an MSA-specific time trend. Standard errors are in parentheses and asterisks indicate statistical significance of coefficients at the following levels: * p < 0.1, ** p < 0.05, ***, p < 0.01. The first six variables in the table are the result of a piecewise regression where separate coefficients are estimated according to the magnitude of the recent decrease in local house prices in 5% intervals. "Decrease in Local House Prices Between" is defined as 1 for decreases in house prices between the lower and upper limit (e.g., 0 and 5%), and 0 otherwise.

TABLE 6
COMPARISON OF MEANS OF ARSON AND ECONOMIC CONDITIONS IN STATES THAT PROHIBIT OR ALLOW MORTGAGE LENDER RECOURSE AFTER FORECLOSURE

	Mean	
	State Prohibits Lender Recourse	State Allows Lender Recourse
National Fire Incident Reporting System		
Arson	5.160	6.857
Total Fires	78.834	104.333
Uniform Crime Reports		
Arson	2.471	0.360
Federal Housing Finance Agency		
Local House Price Growth Last 6 months	0.016	0.017
Decrease in Local House Prices Between		
0 and 5%	0.206	0.178
5% and 10%	0.029	0.016
10% and 15%	0.009	0.003
15% and 20%	0.003	0.001
20% and 25%	0.002	0.001
Greater Than 25%	0.001	0.001
Additional Economic Variables		
Unemployment Rate	1.749	1.705
Growth Rate of Per Capita Income	0.009	0.011
Growth Rate of Population	0.013	0.010
Housing Vacancy Rate	1.922	2.186
Change in Housing Rent	0.014	0.014

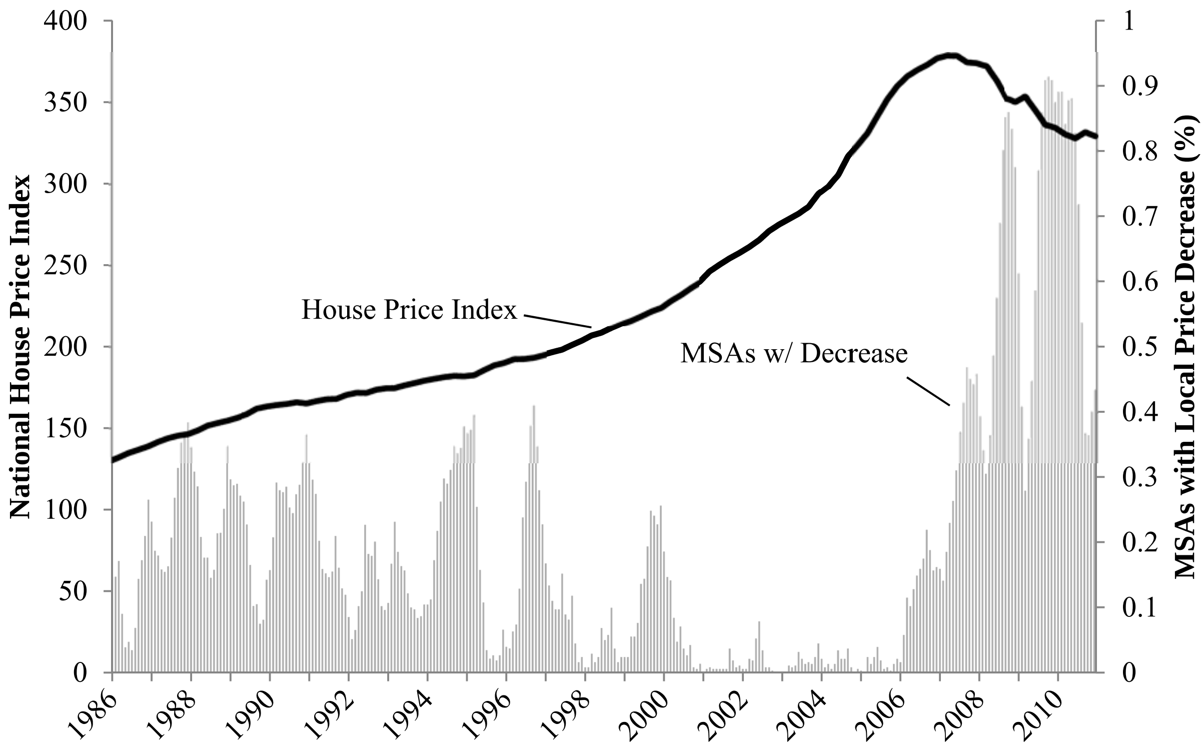
Notes: All arson and fire data are defined as per 1 million MSA residents each month and are limited to those involving a structure. National Fire Incident Reporting System data obtained from the United States Fire Administration and includes 85,944 unique MSA by month observations in 362 MSAs between 1986 and 2010. Uniform Crime Reports data obtained from the Federal Bureau of Investigation. The values listed in the table are the means of variables in equation (1) stratified by whether state laws allow recourse after borrower default on a home loan. The 11 states that prohibit recourse are: Alaska, Arizona, California, Iowa, Minnesota, Montana, North Carolina, North Dakota, Oregon, Washington, and Wisconsin. "Decrease in Local House Prices Between" is defined as 1 for decreases in house prices between the lower and upper limit (e.g., 0 and 5%), and 0 otherwise.

TABLE 7
COMPARISON OF THE PREVALENCE OF ARSON IN STATES THAT PROHIBIT OR ALLOW MORTGAGE LENDER RECOURSE AFTER FORECLOSURE IN THE NATIONAL FIRE INCIDENT REPORTING SYSTEM (NFIRS) DATABASE

	(1)	(2)	(3)
	Arson		F-Test of Difference
	State Prohibits Lender Recourse	State Allows Lender Recourse	[p-value]
Decrease in Local House Prices Between			
0 and 5%	-0.036	0.262**	11.04***
	(0.159)	(0.102)	[0.001]
5% and 10%	0.472	0.742**	1.900
	(0.294)	(0.291)	[0.168]
10% and 15%	0.722	1.934***	4.01**
	(0.447)	(0.588)	[0.045]
15% and 20%	0.045	0.248	0.210
	(0.838)	(0.732)	[0.648]
20% and 25%	-0.022	1.454**	4.66**
	(0.603)	(0.615)	[0.031]
Greater Than 25%	1.232	1.132*	0.040
	(1.148)	(0.630)	[0.848]
Unemployment Rate	-2.323***	0.107	.
	(0.503)	(0.215)	
Growth Rate of Per Capita Income	0.947	0.638	.
	(2.655)	(1.651)	
Growth Rate of Population	9.484	-3.387	.
	(7.216)	(3.104)	
Housing Vacancy Rate	-1.817***	0.195	.
	(0.382)	(0.173)	
Change in Housing Rent	-66.110***	-37.776***	.
	(12.292)	(7.837)	
Observations	19,869	66,075	
Number of MSAs	94	268	
Adjusted R^2	0.545	0.617	

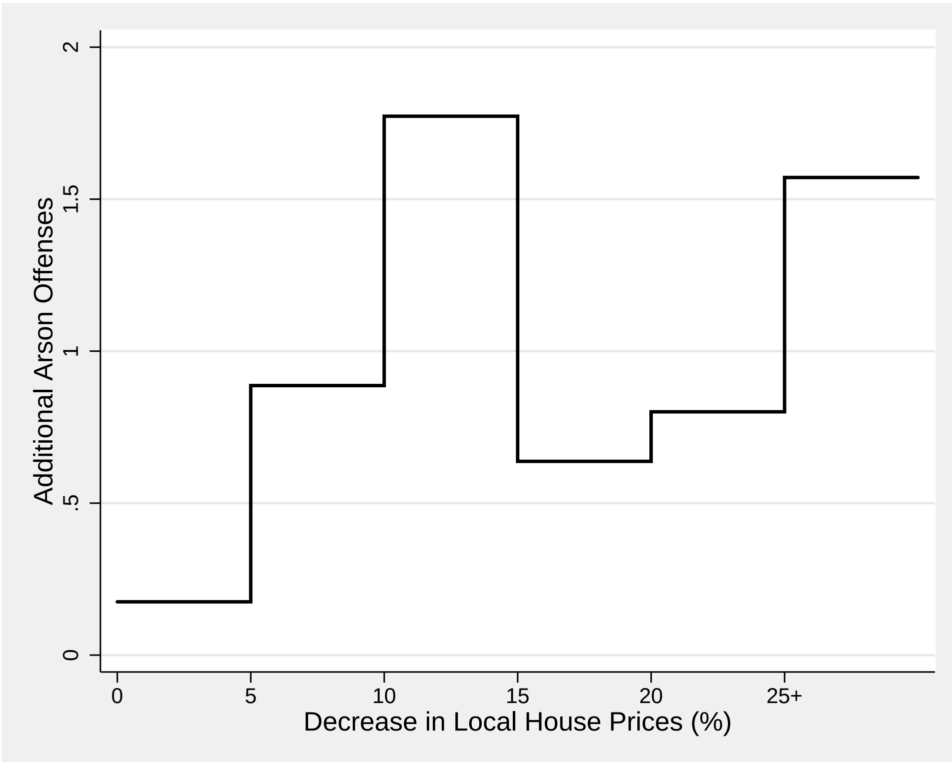
Notes: The dependent variable, Arson, is the monthly number of arson offenses per 1 million MSA residents. We follow Ghent and Kudlyak (2011) and define states that prohibit recourse by mortgage lenders as Alaska, Arizona, California, Iowa, Minnesota, Montana, North Carolina, North Dakota, Oregon, Washington, and Wisconsin. Robust standard errors clustered by MSA and month are reported in parentheses and asterisks indicate statistical significance of coefficients at the following levels: * $p < 0.1$, ** $p < 0.05$, ***, $p < 0.01$. The first six variables in the table are the result of a piecewise regression where separate coefficients are estimated according to the magnitude of the recent decrease in local house prices in 5% intervals. The third column reports the F-statistic and resulting p-value in brackets of a joint test that coefficients for each 5% interval are equal. “Decrease in Local House Prices Between” is defined as 1 for decreases in house prices between the lower and upper limit (e.g., 0 and 5%), and 0 otherwise.

FIGURE 1
US MONTHLY HOUSE PRICES AND PERCENT OF MSAS
WITH A DECREASE IN LOCAL HOUSE PRICES OVER PRECEDING 6 MONTHS



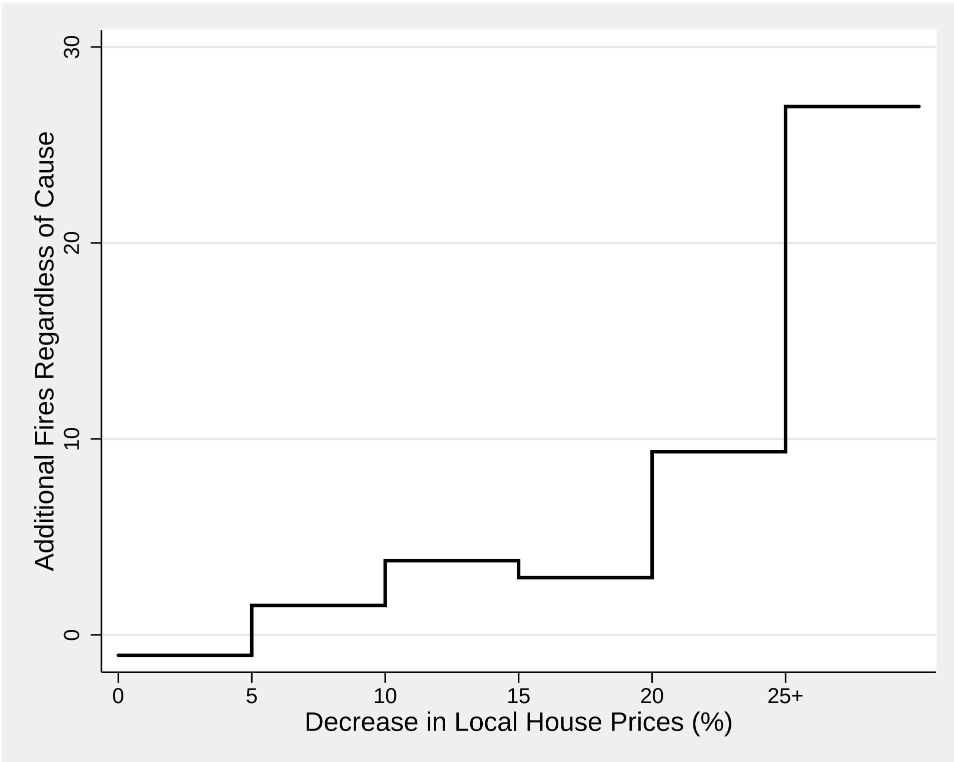
Notes: Data originate from Federal Housing Finance Agency (2012).

FIGURE 2
MONTHLY INCREASE IN ARSON OFFENSES PER 1 MILLION MSA RESIDENTS WITH RESPECT TO DECREASES IN LOCAL HOUSE PRICES



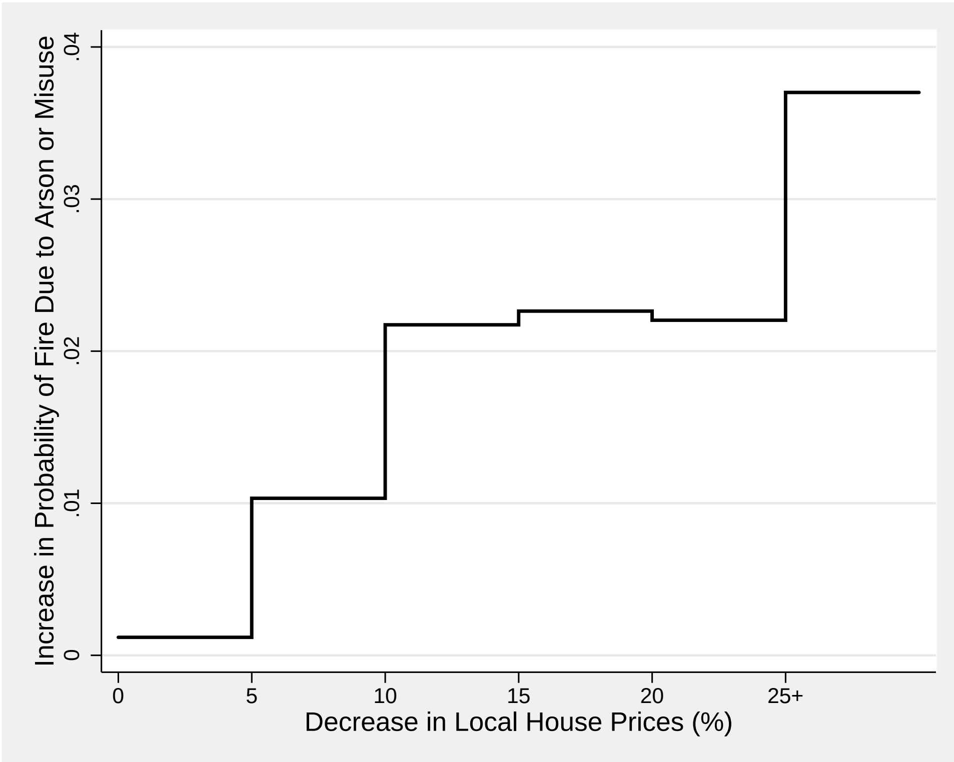
Notes: Authors' calculations from estimating a piecewise linear regression where the dependent variable is defined as the number of arson offenses per 1 million MSA residents per month in the National Fire Incident Reporting System (NFIRS) Data. The solid line in the figure corresponds to column 1 of Table 3 and indicates the estimated increase in the number of arson offenses per 1 million MSA residents when local house prices decrease during the previous 6 months relative to when house prices do not decrease. Estimates are conditional upon unemployment rates, growth rates of per capita income and population, housing vacancy rates, change in quality-adjusted housing rent, MSA and month fixed effects, and a separate linear time trend for each MSA.

FIGURE 3
MONTHLY INCREASE IN NUMBER OF FIRES PER 1 MILLION MSA RESIDENTS WITH RESPECT TO DECREASES IN LOCAL HOUSE PRICES



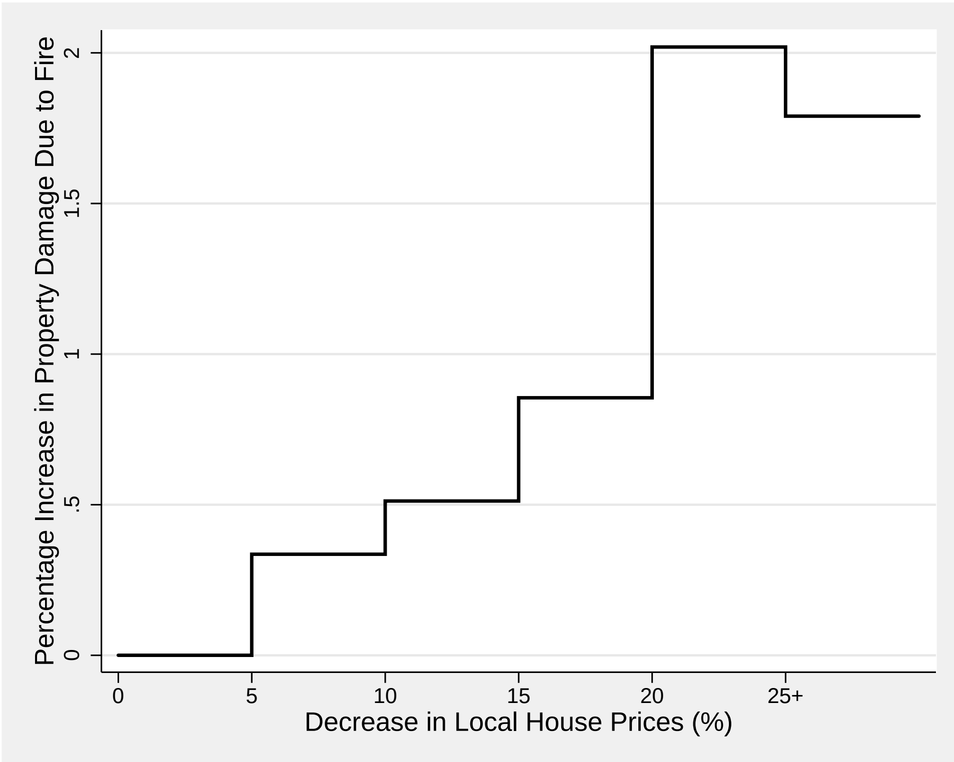
Notes: Authors' calculations from estimating a piecewise linear regression where the dependent variable is defined as the number of fires per 1 million MSA residents per month in the National Fire Incident Reporting System (NFIRS) Data. The solid line in the figure corresponds to column 2 of Table 3 and indicates the estimated increase in the number of arson offenses per 1 million MSA residents when local house prices decrease during the previous 6 months relative to when house prices do not decrease over that time period. Estimates are conditional upon unemployment rates, growth rates of per capita income and population, housing vacancy rates, change in quality-adjusted housing rent, MSA and month fixed effects, and a separate linear time trend for each MSA.

FIGURE 4
CHANGE IN PROBABILITY AN INDIVIDUAL FIRE IS DETERMINED DUE TO ARSON OR MISUSE WITH RESPECT TO SIZE OF DECREASES IN LOCAL HOUSE PRICES



Notes: Authors' calculations from estimating a piecewise linear regression where the dependent variable is defined as a 0,1 indicator variable for whether an individual fire was determined to occur due to arson or misuse of material or product by fire investigators in the National Fire Incident Reporting System (NFIRS) Data. The solid line in the figure corresponds to the figures in column 3 of Table 4 and indicates the estimated increase in the probability the fire was due to arson or misuse when local house prices decrease during the previous 6 months relative to when house prices do not decrease over that time period. Estimates are conditional upon unemployment rates, growth rates of per capita income and population, housing vacancy rates, change in quality-adjusted housing rent, MSA and month fixed effects, and a separate linear time trend for each MSA.

FIGURE 5
CHANGE IN ESTIMATED PROPERTY DAMAGE DUE TO FIRE WITH RESPECT TO DECREASES IN LOCAL HOUSE PRICES



Notes: Authors' calculations from estimating a piecewise linear regression where the dependent variable is defined as the natural log of MSA aggregated dollar loss due to fire each month reported in the in the National Fire Incident Reporting System (NFIRS) Data. The solid line in the figure corresponds to the figures in column 2 of Table 5 indicates the estimated increase in the probability the fire was due to fire when local house prices decrease during the previous 6 months relative to when house prices do not decrease over that time period. Estimates are conditional upon unemployment rates, growth rates of per capita income and population, housing vacancy rates, change in quality-adjusted housing rent, MSA and month fixed effects, and a separate linear time trend for each MSA.